REVISED ENVIRONMENTAL SITE ASSESSMENT

U.S. ARMY CORPS OF ENGINEERS
FORMERLY USED DEFENSE SITE
FORMER CHEMICAL CORPS SUB-TROPICAL BLEACH PLANT

MARSHALL ARMY CHEMICALS PLANT
NATRIUM, MARSHALL COUNTY, WEST VIRGINIA
PROJECT NO. 04877
WORK DIRECTIVE #FUDS/200, CONTRACT NO. DEP8771E

Prepared For:

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POTESTA

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ACRONYMS

ADW	Assessment Derived Waste
AOC	Area of Concern
ASTM	American Society for Testing and Materials
BGS	Below Ground Surface
CLP	Contractor Laboratory Program
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
CSM	Conceptual Site Model
CSR	Code of State Regulations
CT&E	SGS/CT&E Environmental Services, Inc.
DNAPL	Dense Non-Aqueous Phase Liquid
DOT	Department of Transportation
ESA	Environmental Site Assessment
LNAPL	Light Non-Aqueous Phase Liquid
LOD	Level of Detection
LRS	Licensed Remediation Specialist
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PLS	Professional Land Surveyor
PPE	Personal Protective Equipment
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RFI	Remediation Feasibility Investigation
SAWP	Site Assessment Work Plan
SVOC	Semi-Volatile Organic Compound
TAL	Target Analyte List
TOC	Top of Casing
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VI	Verification Investigation
VOC	Volatile Organic Compound
VRRA	Voluntary Remediation and Redevelopment Act
WVDEP	West Virginia Department of Environmental Protection
WVDEP-OER	WVDEP, Division of Land Reclamation - Office of Environmental Remediation

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1.0 EXECUTIVE SUMMARY

The West Virginia Department of Environmental Protection, Division of Land Restoration, Office of Environmental Remediation (WVDEP-OER) retained Potesta & Associates, Inc. (POTESTA) to conduct environmental site assessment activities at the former Marshall Army Chemical Plant (site) following the requirements set forth in the Voluntary Remediation and Redevelopment Act (VRRA) program. The former Marshall Army Chemical Plant (site) is located in Natrium, Marshall County, West Virginia. The site is bordered to the west by the Ohio River, to the south and north by a PPG Industries, Inc. (PPG) plant, and to the east by portions of the PPG plant with a PPG-owned nature preserve beyond. The site is currently owned and operated as a chemical manufacturing facility by PPG. The site has been historically utilized for industrial purposes since the 1940s. Neighboring properties have been used for industrial purposes or have been largely undeveloped.

Mr. Roderic E. Moore, with POTESTA, serves as the Project Manager for the project. Based on available data, POTESTA developed a conceptual site model (CSM) and developed a *Site Assessment Work Plan* (SAWP) to assess conditions at the site with respect to the target analytes and media of concern as part of the *Environmental Site Assessment* (ESA). POTESTA performed an assessment of the potentially impacted media at the site through the installation and sampling of soil borings and groundwater monitoring wells. The scope of services for this project generally followed Section 2.0 of the VRRA *Guidance Manual* (WVDEP, 2000). The target analytes at the site were:

- Volatile Organic Compounds (VOCs);
- Semivolatile Organic Compounds (SVOCs);
- Polynuclear Aromatic Hydrocarbons (PAHs);
- Pesticides;
- Polychlorinated Biphenyls (PCBs); and,
- Target Analyte List (TAL) and the Target Compound List (TCL) Metals and Cyanide.

POTESTA promoted quality assurance by maintaining site logs, documenting field activities, and analyses of quality assurance/quality control (QA/QC) samples. QA/QC samples were collected and analyzed to assess laboratory performance and gauge the possibility of cross-contamination associated with both field and laboratory activities.

Thirty-one target analytes were detected at concentrations greater than their respective screening values in the surface soil. Of these, 27 target analytes were detected at concentrations greater than their respective Migration to Groundwater standards in the surface soil. Nineteen target analytes were detected at concentrations greater than their Residential RBCs in the surface soil. Five target analytes were detected at concentrations greater than their Industrial RBCs in the surface soil: 1,4-dichlorobenzene (VOC), hexachlorobenzene and hexachlorobutadiene (SVOCs), benzo(a)pyrene (PAH), and arsenic (metal).

Thirty-six target analytes were detected at concentrations greater than their respective screening values in the subsurface soil. Of these, 30 target analytes were detected at concentrations greater than their respective Migration to Groundwater standards in the subsurface soil. Twenty-two target analytes were detected at concentrations greater than their Residential Risk-Based Concentrations (RBCs) in the subsurface soil. Eleven target analytes were detected at concentrations greater than their Industrial RBCs in the subsurface soil: 1,1,2,2-tetrachloroethane, 1,4-dichlorobenzene, carbon tetrachloride, chloroform, tetrachloroethene, and trichloroethene (VOCs), benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene (PAHs).

POTESTA has identified 1,1,2,2-tetrachloroethane, 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, carbon tetrachloride, chlorobenzene, chloroform, cis-1,2-dichloroethene, methylene chloride, tetrachloroethene, trichloroethene, and vinyl chloride (VOCs), bis(2-ethylhexyl)phthalate and hexachloroethane (SVOCs), beta-BHC and dieldrin (pesticides), and dissolved arsenic, mercury, thallium, and vanadium (metals) in groundwater samples at concentrations that exceeded their respective Groundwater RBCs.

POTESTA did not identify soil sample contaminants of potential concern (COPCs) in association with areas of concern (AOCs). Groundwater contamination seems pervasive.

POTESTA measured groundwater elevations in the 12 monitoring wells installed during the ESA. A potentiometric surface map drawn using shallow well data indicates the groundwater flow is from the east, northeast to the west, and southwest toward the Ohio River under the eastern portion of the site. The groundwater elevations measured in wells adjacent to the Ohio River are approximately 10 feet higher than the nearest offsets. Based on these data, POTESTA projects the groundwater under the western portion of the site to flow from the west, southwest to the east, and northeast away from the Ohio River. POTESTA's calculations of groundwater elevations coincide with the groundwater elevations presented in a previous assessment of the site.

To adequately characterize the site, POTESTA recommends the following:

- Reviewing available sediment and surface water data that may exist from the Ohio River adjacent to the site;
- If necessary, collecting and analyzing sediment and surface water samples along riverbanks of the Ohio River adjacent to the site; and,
- Evaluating the perimeter monitoring system as recommended by International Technology Corporation (IT) (IT, February 1990).

If requested, POTESTA will prepare a supplemental work plan for the WVDEP that will describe the additional assessment services to be performed in response to the listed recommendations.

2.0 INTRODUCTION AND BACKGROUND

POTESTA, on behalf the WVDEP-OER, performed this ESA to obtain soil and groundwater samples as part of an expanded ESA of the former Marshall Army Chemical Plant (MACP) located in Natrium, Marshall County, West Virginia. POTESTA reviewed previous site assessment data provided by the WVDEP to develop a CSM for the project. Based on the information available, POTESTA identified VOCs, SVOCs, PAHs, pesticides, PCBs, and metals as the target analytes at the site. This ESA is designed to further assess the conditions at the site.

2.1 Site Description

The former Marshall Army Chemical Plant site consists of approximately 78 acres from a larger 3,200-acre facility owned and operated by PPG. The approximate site coordinates are 39.7520 north latitude and 80.8574 west longitude. The general location of the facility is presented as **Figure 1** (Figures 1 through 12 are presented in **Appendix A**), which was reproduced from the United States Geological Survey (USGS) 7.5-minute topographical quadrangle map of New Martinsville, West Virginia and Powhatan Point, Ohio.

The site is bordered to the west by the Ohio River. To the south and north is the PPG plant. To the east are portions of the PPG plant with a PPG-owned nature preserve beyond.

2.2 Geologic Setting and Soils

The site lies in the unglaciated portion of the Appalachian Plateau physiographic province. The topography is characterized by deeply dissected, relatively flat-lying rock strata. Bedrock at the site is part of the Dunkard Group, Permian and/or Pennsylvanian System, Paleozoic Era in age. The Dunkard Group consists of cyclic sequences of sandstone, red beds, shale, limestone, and coal (West Virginia Geological and Economic Survey, 1969).

2.3 Hydrogeologic Setting

The site is adjacent to the Ohio River. The depth to groundwater at the site is between 11.84 and 45.80 feet below ground surface (bgs). Groundwater elevations and estimated direction of flow are discussed in **Sections 4.2.4** and **5.4**.

2.4 Current Use of the Subject Site

The site is currently owned and operated as a chemical manufacturing facility by PPG (**Figure 2**).

2.5 Historical Site Information

The United States government constructed the former Marshall Army Chemicals Plant during World War II to produce sub-tropical bleach and various chlorinated chemical products including:

- Perchloroethylene
- Tetrachloroethene
- Trichloroethane

For a period between 1944 and 1952, Glyco operated the Marshall Plant for the manufacture of specialty compounds including:

- Glycol
- Glycerine
- Amines
- Amides

PPG obtained the site in the early 1950s. PPG produces chlorine, caustic soda, hydrogen gas, sodium sulfide, sodium sulfhydrate, sodium hydroxide pellets, ammonia, hydrogensulfide, calcium hypochlorite, monochlorobenzene, dichlorobenzene and carbon bisulfide. Previously, PPG produced benzene hexachloride, barium compounds, titanium tetrachloride, and titanium dioxide at the site.

2.6 Previous Environmental Assessments

In August 1992, PPG received a Verification Investigation (VI) report for the Natrium Plant, including the former Marshall Plant, conducted by IT. In response to the VI, PPG developed and implemented a groundwater investigation to establish whether further assessment or remediation was warranted. The VI included the installation of groundwater monitoring wells and collection and analyses of soil and groundwater samples.

In October 1992, PPG submitted to the United States Environmental Protection Agency (USEPA) a report titled *Description of Current Conditions, RCRA Facility Investigation for the PPG Industries, Inc., Natrium Plant, New Martinsville, West Virginia*, prepared by ICF Kaiser Engineers, Inc, (ICF). The *Current Conditions* report included information concerning current and historical operations at the Marshall Plant.

PPG entered the Natrium facility into the Resource Conservation and Recovery Act (RCRA) Facility Investigation process. Field and analytical data for the site were collected as part of two interim actions and investigations in May 1994 (termed "Phase I") and October 1994 (termed "Phase II") by ICF. The results of the Phase I and Phase II activities and interim actions were reported to PPG by ICF in a report titled *Interim Action and Investigation Report for Selected RFI SWMUS and AOCs* (ICF, 1996).

The previous environmental assessments for PPG identified nine areas of concern (AOCs) at the site. These AOCs include:

- Former Sanitary Landfill
- RCRA Hazardous Waste Drum Storage Area
- Storage Tanks
- Former Process and Sewer Areas
- Used Oil Drum Storage Unit
- Used Drum Storage Area
- Former 2,000-Gallon Used Oil Storage Tank (removed)
- Former Electrical Substation
- Dumpster Trash Compactor Unit

The locations of these AOCs are presented on **Figure 2**.

POTESTA also assessed the area near the Waste Ponds/Sludge Basins #1 and 3.

Based on a review of previous assessment reports, POTESTA concluded PPG conducted industrial activities in the vicinity of the Sanitary Landfill, RCRA Hazardous Waste Drum Storage Area, Storage Tanks, Used Oil Drum Storage Unit, Used Drum Storage, 2,000-Gallon Used Oil Storage Tank, and Dumpster Trash Compactor Unit. Both the MACP and PPG have operated the Process and Sewer Areas, Electrical Substation, and the Waste Ponds/Sludge Basins.

3.0 SCOPE OF SERVICES

POTESTA performed an ESA on the site in general accordance with applicable regulations and standard industry practices. The scope of services for this project generally followed Section 2.0

of the *West Virginia VRRA Guidance Manual* (WVDEP, 2000) and was developed to assess constituents and media of potential concern. This ESA followed the health and safety procedures, laboratory selection, field screening techniques, quality assurance/quality control procedures, and decontamination procedures presented as part of the SAWP.

POTESTA performed field activities at the site between February 10 and April 24, 2003. The SAWP was designed to identify potential contaminants of concern, their source area, and media affected by systematically sampling the soil and groundwater at the site. Assessment activities included the following:

- Collection of surface and subsurface soil samples;
- Installation and development of monitoring wells;
- Measurement of groundwater elevations;
- Purging of monitoring wells and collection of groundwater samples; and
- Review of laboratory analytical results.

POTESTA performed the soil and groundwater assessment in general accordance with methods approved by the USEPA Contractor Laboratory Program (CLP) and the WVDEP. Samples were analyzed using analytical methods that are appropriate for identifying chemicals on the Target Analyte List and Target Compound List. The TAL/TCL lists were originally derived from the USEPA Priority Pollutant List. Since then, compounds have been added to, and deleted from, these lists based on advances in analytical methods, evaluation of method performance data, and the needs of the USEPA Superfund program. The lists are now referred to as the TCL. POTESTA submitted samples to SGS/CT&E Environmental Services, Inc. (CT&E), a West Virginia certified laboratory. CT&E's Level 3 (CLP-like format) Data Reporting Package was performed on 10 percent of the samples submitted for analyses.

4.0 SITE ASSESSMENT METHODOLOGY

POTESTA performed an assessment of the potentially impacted media at the site through the installation and sampling of 41 soil borings and 12 groundwater monitoring wells (6 shallow and deep groundwater monitoring well pairs). POTESTA selected the sample locations after consideration of several factors, including previous sampling by PPG, by establishing a grid-sampling pattern, anticipated direction of groundwater flow, and potential contaminant migration pathways.

Thirty-three soil boring locations were selected based on the nodes of a systematic 350-foot triangular grid sampling scheme that was superimposed onto the site. The sampling grid was designed using the *Visual Sample Plan Version 1.0* computer model, which was prepared for the USEPA (Davidson, et. al 2001). A statistical analysis predicts the sampling scheme has a 95 percent probability of identifying hot spots having a radius of 181 feet or larger.

Soil borings were advanced to a depth of 50 feet bgs, groundwater, or refusal, whichever was reached first. Surface soil samples (i.e., soil 0-2 feet bgs) from the borings were submitted for laboratory analyses. Second soil samples from the borings, recovered from a depth greater than 2 feet bgs (subsurface soil), were also submitted for laboratory analyses.

POTESTA also advanced eight additional soil borings at locations selected to evaluate the previously identified AOCs at the site, which included the Former Sanitary Landfill, RCRA Hazardous Waste Drum Storage Area, Storage Tank Location, Former Process and Sewer Areas, Used Oil Drum Storage Unit, Used Drum Storage Area, Former 2,000-Gallon Used Oil Storage Tank (removed), Former Electric Substation, and Dumpster Trash Compactor Unit.

4.1 Soil Assessment

POTESTA used a Geoprobe® direct-push unit to advance soil borings using a Macro Core or Dual-Tube sampler. The soil boring sample locations are presented in **Figure 3**. The exact locations and number of soil borings were established through coordination with PPG and field conditions at the site. This assessment was limited to surface and subsurface media outside the buildings. An assessment of the buildings was not performed.

POTESTA collected surface and subsurface soil samples from February 10 through March 13, 2003, during the advancement of 41 soil borings. POTESTA used a Geoprobe® direct push unit to collect the soil samples. The soil borings were advanced to depths ranging from 5.5 to 48 feet bgs.

From March 24 through April 3, 2003, POTESTA collected surface and subsurface soil samples during the installation of 12 monitoring wells. During completion of the monitoring wells, POTESTA collected soil samples at 5-foot intervals using a 2-inch outside diameter split spoon sampler to establish depth to groundwater and lithology. The monitoring wells were advanced to depths ranging from 23 to 85.6 feet bgs.

4.1.1 Soil Classification and Field Screening

Soil samples were visually classified and logged in the field by an experienced staff technician in general accordance with the Unified Soil Classification System (modified by American Society for Testing and Materials [ASTM], 2000). Copies of the Visual Log of Environmental Boring forms are presented in **Appendix C**.

POTESTA collected samples directly from the recovered material, prior to mixing/homogenizing, for VOC analyses using Terra Core™ samplers per USEPA Method 5035. The Terra Core™ samplers are single-use sampling tools that collect approximately 5 grams of soil. The 5 grams of collected soil were then transferred to one of three 40-millilter (mL) vials. Two of the vials contained a sodium bisulfate preservative; the third vial contained a methanol preservative. The process was repeated until a 5-gram sample had been placed into the three containers. The vials were then capped and placed into a shipping container. After mixing/homogenating the remaining sample, additional containers were filled for analyses the remaining target analytes.

POTESTA placed a portion of the soil into a re-sealable sample bag. This portion of soil was screened in the field for the presence of organic vapors using an organic vapor analyzer equipped with a photoionization detector (PID). The sample to be field screened (bag sample) was vigorously shaken to aid with the release of organic vapors and allowed to stabilize. The bag was then slightly opened and the detector probe tip was inserted for screening.

POTESTA submitted 105 soil samples to CT&E. Soil samples selected for analysis were shipped in a cooler (maintained @ ≤4°C), with proper chain-of-custody documentation.

4.1.2 Analytical Parameters - Surface and Subsurface Soil Samples

Samples from the borings were submitted to CT&E for analyses of the following target analytes:

- VOCs,
- SVOCs,
- PAHs,
- Pesticides,
- PCBs, and
- TAL/TCL Metals.

A list of the target analytes evaluated in the surface and subsurface soil samples is presented in **Table 1** (Tables 1 through 14 are presented in **Appendix B**).

4.2 Groundwater Assessment

From March 24 through April 3, 2003, POTESTA installed six pairs of groundwater monitoring wells at the site. Well pairs consisted of shallow and deep aquifer wells. The shallow wells were installed to depths ranging from 23 to 48 feet bgs and were designed to sample groundwater for dissolved analytes and potential Light Non-Aqueous Phase Liquids (LNAPL) at the soil/groundwater interface. The deep wells were installed to depths ranging from 62 to 85.6 feet bgs and were designed to sample groundwater for dissolved analytes and potential Dense Non-Aqueous Phase Liquids (DNAPL) in the unconsolidated sediments down to the underlying bedrock. The locations of the monitoring wells are presented in **Figure 4**. Monitoring wells were installed by a Certified Monitoring Well Driller in accordance with *Monitoring Well Regulations* West Virginia Code of State Regulations Title 47, Series 59 (47CSR59), and *Monitoring Well Design Standards* 47CSR60. POTESTA used rotary drilling techniques and 4.25-inch inside diameter hollow stem augers to install the monitoring wells.

The well registration numbers for the monitoring wells are as follows:

Monitoring Well	Registration No.
MWDEP-1A	WV00104-0013-03
MWDEP-1B	WV00104-0014-03
MWDEP-2A	WV00104-0015-03
MWDEP-2B	WV00104-0016-03
MWDEP-3A	WV00104-0017-03
MWDEP-3B	WV00104-0018-03
MWDEP-4A	WV00104-0019-03
MWDEP-4B	WV00104-0020-03
MWDEP-5A	WV00104-0021-03
MWDEP-5B	WV00104-0022-03
MWDEP-6A	WV00104-0023-03
MWDEP-6B	WV00104-0024-03

Copies of the Monitoring Well Construction Diagrams and Monitoring Well Construction Documentation Forms GW-MWC, are presented in **Appendix C**.

The monitoring wells have 10 to 15 feet of 0.010-inch slotted PVC screen set at total depth and the appropriate length of schedule 40 PVC riser to stick up approximately three feet. The monitoring wells have bottom end caps (screw-type) and locking, watertight well caps. The monitoring wells have a sand filter pack (#4 or #5) to 2 feet above the screen, a 2-foot bentonite seal, and are grouted with a cement-bentonite grout to the surface. Monitoring wells are equipped with an aboveground protective steel cover set in a concrete pad (minimum 2 feet by 2 feet). Four 4-inch diameter pipe bollards at the pad corners protect the wellheads. The bollards are set 2 feet deep in concrete with approximately 3 feet aboveground. The bollards are capped to prevent moisture from entering. Wellheads and bollards are painted bright orange to allow recognition and aid with protection of the wellhead.

POTESTA established the top of casing elevation by conventional level surveying techniques and by referencing the elevations to a known benchmark.

POTESTA also installed six temporary piezometers (one-inch PVC pipe) to depths of up to 80 feet bgs for the purposes of evaluating groundwater flow characteristics. The locations of the piezometers were established by survey.

4.2.1 Monitoring Well Development

From April 1 through April 9, 2003, POTESTA developed the monitoring wells by evacuating groundwater and suspended solids using disposable polyethylene bailers. Development activities continued until measurements of pH, temperature, and conductivity stabilized and the evacuated water sufficiently clarified. Copies of the Field Well Development forms are presented in **Appendix E**. POTESTA managed the water evacuated during development as described in **Section 4.5**.

4.2.2 Groundwater Sampling and Analysis

From April 10 through April 11, 2003, POTESTA collected groundwater samples from the six monitoring well pairs. Prior to collecting groundwater samples, POTESTA measured the depth to groundwater under static conditions. POTESTA purged the monitoring wells using disposable polyethylene bailers. Purging continued until measurements of pH, temperature, and conductivity stabilized and the purged water sufficiently clarified. Copies of the Field Well Purge and Sample forms are presented in **Appendix F**.

POTESTA collected groundwater samples from the monitoring wells in general accordance with procedures outlined in the *RCRA Ground-Water Monitoring Technical Enforcement Guidance Document* (USEPA, 1992) and the *Standard Operating Procedures for Groundwater Sampling* (WVDEP – Division of Water Resources, 2000).

Groundwater samples were shipped to CT&E in a cooler (maintained @ ≤4°C), with proper chain-of-custody documentation.

4.2.3 Analytical Parameters – Groundwater Samples

The groundwater samples were submitted for analyses of the following target analytes:

- VOCs;
- SVOCs;
- PAHs;
- Pesticides;
- PCBs; and,
- TAL/TCL Metals.

A list of the analytes evaluated in the groundwater samples is presented in **Table 2**.

4.2.4 Hydrogeologic Study

POTESTA measured groundwater elevations in the monitoring wells and temporary piezometers prior to sampling. The groundwater elevation measurements were referenced to the top of casing (TOC) for the corresponding monitoring well. The TOC elevation was established by conventional level surveying techniques, referencing the elevations to a known benchmark. The depth to water below top of casing and the elevation of groundwater at the monitoring wells are presented in **Table 3**.

4.2.5 Piezometer Results

POTESTA reviewed groundwater elevations measured in the six piezometers installed at the site. A summary of the groundwater elevations measured in those piezometers is presented on **Table 3**. POTESTA has concluded that the wide range of water elevations measured in the uncased piezometers is indicative of the influence from shallow, discontinuous, aquifers. POTESTA did not use groundwater elevations obtained from the piezometers in calculating the groundwater potentiometric surface at the site.

4.3 Quality Assurance/Quality Control

POTESTA promoted quality assurance by maintaining site logs, documenting field activities, and analyses of QA/QC samples. QA/QC samples were collected and analyzed to assess laboratory performance and gauge the possibility of cross-contamination associated with both field and laboratory activities. The following QA/QC samples were submitted for analysis:

- 24 replicate soil samples;
- 1 groundwater duplicate sample;
- 1 field rinse blank per day of field work (a total of 24); and
- 1 trip blank per laboratory sample shuttle (a total of 10).

Replicate soil samples were used to assess laboratory performance of soil analyses.

Duplicate water samples were used to assess laboratory performance of water analyses. POTESTA collected a duplicate groundwater sample, MWDEP-D, from MWDEP-4A on April 10, 2003, during groundwater sampling activities.

Rinse blanks were used to establish whether the decontamination procedures were adequate. Rinse blanks were collected by pouring distilled water over and through the decontaminated equipment into sample containers. From February 10 through March 13, 2003, POTESTA collected rinse blanks during soil boring advancement. From March 24 through April 3, 2003, POTESTA collected rinse blanks during monitoring well installation.

Rinse blanks, replicate soil samples, and duplicate groundwater samples were submitted for analyses of the same analytes as their corresponding samples.

Trip blanks were used to detect possible cross-contamination of VOCs. POTESTA submitted ten trip blanks for analyses of VOCs. One trip blank per sample cooler was shipped to the laboratory.

4.4 Decontamination Procedures

4.4.1 Geoprobe® and Drilling Equipment

During the subsurface assessment, decontamination procedures were followed for multi-use equipment. These procedures included decontamination of the probe rig, drilling rig, and associated equipment using a hot wash pressure sprayer prior to arrival on-site. The down-hole sampling equipment was decontaminated between borings and sample intervals using the following procedure:

- Wash with a non-phosphate biodegradable detergent and water solution,
- Rinse with potable water,
- Rinse with laboratory-grade nitric acid,
- Rinse with laboratory-grade hexane, and,
- Final rinse with distilled water.

The Geoprobe® cutting shoe, split-spoon samplers, drilling augers, and rod string were decontaminated in a temporary decontamination pad consisting of a plastic bucket, water sprayer, and brushes.

4.4.2 Sampling and Field Equipment

POTESTA used single-use disposable sampling equipment (e.g., gloves, plastic spoons, etc.) when appropriate. Disposable materials were not decontaminated and were discarded after use.

4.4.3 Field Screening Equipment

Soil field screening equipment (i.e., PID) was decontaminated by wiping the plastic tip of the instrument (probe) with a paper towel between uses.

Water field screening equipment (i.e., water level indicator) was decontaminated before use by washing in a biodegradable soap solution and rinsing with distilled water.

4.5 Assessment Derived Waste Generation and Disposal

POTESTA managed assessment-derived wastes (ADW) during the ESA. These included trash, used personal protective equipment (PPE), soil cuttings, decontamination liquids, and monitoring well purge/development water generated during sampling activities. The work area was kept free of excess trash, rags, PPE, etc. during implementation of the SAWP.

Soil cuttings generated during soil boring advancement and monitoring well installation were placed in 55-gallon drums approved by the United States Department of Transportation (DOT). Liquids produced during development, purging, sampling, and decontamination were also placed in DOT-approved 55-gallon drums. The drums were labeled, removed from the site, and disposed. Copies of the Non-Hazardous Waste Manifests are presented in **Appendix G**.

4.6 Site Assessment QA/QC

POTESTA followed the procedures and practices presented in the Quality Assurance Project Plan (QAPP), part of the SAWP, so that information, data, and decisions derived from or based on data acquired during the ESA were technically sound, valid, and properly documented.

4.7 QA/QC Reporting

POTESTA requested that at least 10 percent of the samples be reported in a CT&E Level 3 data reporting package, which included the following:

CLP format packages follow USEPA guidelines for reporting including the following where applicable:

- Case Narrative
- QC Summaries
    - Method/Reagent Blanks
    - Calibration (Initial and Continuing)
    - Matrix Spikes and Spike Duplicates
    - Sample and Sample Duplicates
    - Surrogate Percent Recoveries
    - Internal Standards and Retention Time Summaries
    - Gas Chromatography/Mass Spectrometry System Performance Checks
    - Gas Chromatography Confirmations
    - Tentatively Identified and Identified Compounds Summaries

CT&E also reported the sample results in Level 1 reporting packages, which include the following deliverables:

- Analytical Report (includes surrogate recoveries for organic methods)
- Chain-of-Custody

The CT&E Level 1 reporting packages are presented in **Appendix H**. The Level 3 reports are available upon request.

4.8 Surveying

On April 26, 2003, POTESTA performed surveying at the site under the supervision of a Professional Land Surveyor (PLS) licensed in the State of West Virginia. Surveying was performed in general accordance with the SAWP. Soil borings and monitoring wells were surveyed and referenced to a known benchmark.

5.0 SITE ASSESSMENT RESULTS

The site assessment results presented in this report are limited to those analytes in soil and water samples detected at concentrations greater than their respective levels of detection (LOD). Because of the number of analytes targeted by this assessment and the volume of data generated by these analyses, only the analytes detected above laboratory reporting limits in one or more samples are included in the tables referenced in this section.

Soil samples analytical results were screened against their respective Residential, Industrial, and Migration to Groundwater VRRA RBC values. Groundwater samples analytical results were screened against their respective Groundwater VRRA RBC values.

5.1 Surface Soil Sampling Results

POTESTA submitted 45 surface soil samples for laboratory analysis. Target analytes that were detected at concentrations greater than their respective LOD for the surface and subsurface soil samples are presented in **Table 4**. A summary of the target analytes detected in concentrations greater than their respective LODs in the surface soil is presented in **Table 5**. Locations of surface soil analytical results that exceed VRRA RBCs are presented in **Figure 5**.

POTESTA compared the surface soil analytical results to the West Virginia Migration to Groundwater standards as presented in 60CRS3, Table 60-3B, WV De Minimis Levels (Revised January 2002). The VOCs 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethane, 1,2,4-trichlorobenzene, 1,2-dibromo-3-chloropropane, 1,2-dichlorobenzene, 1,4-dichlorobenzene, benzene, carbon tetrachloride, chloroform, tetrachloroethene, toluene, and trichloroethene, the SVOCs 1,2,4,5-tetrachlorobenzene, acetophenone, carbazole, hexachlorobenzene, hexachlorobutadiene, and hexachloroethane, the PAHs benzo(a)anthracene, benzo(b)fluoranthene, and naphthalene, the pesticides alpha-BHC, beta-BHC, and gamma-BHC (Lindane), and the metals arsenic, barium, and chromium, were detected at concentrations in the surface soil, which exceeded their respective Migration to Groundwater standards.

POTESTA compared the surface soil analytical results to the West Virginia De Minimis RBCs for Residential Soil (Residential RBCs) as presented in 60CRS3, Table 60-3B, WV De Minimis Levels (Revised, January 2002). The VOCs 1,1,2,2-tetrachloroethane, 1,4-dichlorobenzene, benzene, carbon tetrachloride, and tetrachloroethene, the SVOCs hexachlorobenzene, hexachlorobutadiene, and hexachloroethane, the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene, the pesticides alpha-BHC and beta-BHC, and the metals arsenic, barium, chromium, and iron were detected at concentrations in the surface soil, which exceeded their respective Residential RBCs.

POTESTA also compared the surface soil analytical results to the West Virginia De Minimis RBCs for Industrial Soil (Industrial RBCs) as presented in 60CRS3, Table 60-3B, WV De Minimis Levels (Revised, January 2002). The VOC 1,4-dichlorobenzene, the SVOCs hexachlorobenzene and hexachlorobutadiene, the PAH benzo(a)pyrene, and the metal arsenic were detected at concentrations in the surface soil, which exceeded their respective Industrial RBCs.

One VOC, 1,4-dichlorobenzene, exceeded its Industrial RBC in the surface soil sample collected from SB-40. The SVOC hexachlorobenzene exceeded its Industrial RBC in the surface soil samples collected from SB-40, SB-41, and MWDEP-6A and the SVOC hexachlorobutadiene exceeded its Industrial RBC in the surface soil samples collected from SB-40 and MWDEP-6A. One PAH, benzo(a)pyrene, exceeded its Industrial RBC in the surface soil sample collected from SB-36. Arsenic exceeded its Industrial RBC in the surface soil samples collected from SB-31, SB-33, SB-36, and MWDEP-2B. POTESTA concluded no other Industrial RBCs were exceeded in surface soil samples analyzed.

5.2 Subsurface Soil Sampling Results

POTESTA submitted up to 61 subsurface soil samples for laboratory analysis, depending on sample recovery. Target analytes that were detected at concentrations greater than their respective LOD for the surface and subsurface soil samples are presented in **Table 4**. A summary of the target analytes detected in concentrations greater than their respective LODs in the subsurface soil is presented in **Table 6**. Locations of subsurface soil analytical results that exceed VRRA RBCs are presented in **Figure 6**.

POTESTA compared the subsurface soil analytical results to the West Virginia Migration to Groundwater standards. The VOCs 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, 1,2-dibromo-3-chloropropane, 1,4-dichlorobenzene, benzene, carbon tetrachloride, chlorobenzene, chloroethane, chloroform, cis-1,2-dichloroethane, ethylbenzene, methylene chloride, tetrachloroethene, trichloroethene, vinyl chloride, the SVOCs carbazole, dibenzofuran, and hexachloroethane, the PAHs acenaphthene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, and pyrene, the pesticides alpha-BHC and beta-BHC, and the metal chromium were detected at concentrations in the subsurface soil, which exceeded their respective Migration to Groundwater standards.

POTESTA compared the subsurface soil analytical results to their respective Residential RBCs. The VOCs 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, 1,4-dichlorobenzene, carbon tetrachloride, chloroform, tetrachloroethene, and trichloroethene, the SVOCs carbazole and hexachlorobenzene, the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene, the pesticide beta-BHC, and the metals arsenic, chromium, iron, and vanadium were detected at concentrations in the subsurface soil, which exceeded their respective Residential RBCs.

POTESTA compared the subsurface soil analytical results to their respective Industrial RBCs. The VOCs 1,1,2,2-tetrachloroethane, 1,4-dichlorobenzene, carbon tetrachloride, chloroform, tetrachloroethene, and trichloroethene, and the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were detected at concentrations in the subsurface soil, which exceeded their respective Industrial RBCs.

VOCs 1,1,2,2-tetrachloroethane, carbon tetrachloride, chloroform, tetrachloroethene, and trichloroethene exceeded their respective Industrial RBCs in subsurface soil samples collected from SB-32. The VOC 1,4-dichlorobenzene exceeded its Industrial RBC in the subsurface soil sample collected from SB-29. PAHs Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene exceeded their respective Industrial RBCs in subsurface soil samples collected from MWDEP-4B. POTESTA concluded no other Industrial RBCs were exceeded in subsurface soil samples analyzed.

5.3 Groundwater Sampling Results

POTESTA submitted 12 groundwater samples for laboratory analyses. Laboratory analytical results for analytes detected at concentrations greater than their respective LOD in the groundwater samples are presented in **Table 7**. A summary of the target analytes detected in concentrations greater than their respective LODs in groundwater is presented in **Table 8**. Locations of groundwater analytical results that exceed VRRA RBCs are presented in **Figure 7** and **Figure 8**.

POTESTA also compared the groundwater analytical results to their respective Groundwater RBCs. The VOCs 1,1,2,2-tetrachloroethane, 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, carbon tetrachloride, chlorobenzene, chloroform, cis-1,2-dichloroethene, methylene chloride, tetrachloroethene, trichloroethene, and vinyl chloride, the SVOCs bis(2-ethylhexyl)phthalate and hexachloroethane, the pesticides beta-BHC and dieldrin, and the metals arsenic, mercury, thallium, and vanadium exceeded their respective Groundwater RBCs. POTESTA concluded no other Groundwater RBCs were exceeded in the groundwater samples analyzed.

5.4 QA/QC Sampling Results

5.4.1 Replicate Soil Samples

POTESTA compared the laboratory analytical results for the replicate samples to the results generated for their corresponding soil samples (**Appendix H**). Replicate samples were thoroughly mixed before placement into soil jars; however, characteristics of the target analytes and the nature of the soil may inhibit complete homogeneity of samples.

A comparison of laboratory analytical results for replicate soil samples is presented in **Table 9**. POTESTA did not identify significant differences between the analytical results generated from the samples and their replicates.

5.4.2 Replicate Groundwater Samples

POTESTA compared the laboratory analytical results from the replicate samples to the results generated from the corresponding groundwater samples (**Appendix H**). Target analytes detected at concentrations greater than the LOD for MWDEP-4A and MWDEP-D are presented in **Table 10**. POTESTA did not identify significant differences between the analytical results generated by MWDEP-4A and MWDEP-D.

5.4.3 Rinse Blanks

Target analytes detected in the rinse blanks are (**Table 11**):

- 4,4-DDT was detected in RB 4-03-03.
- Acetone was detected in RB-1 2-24-03, RB-1 2-25-03, RB 3-5-03, RB 3-6-03, RB 3-7-03, RB 3-10-03, RB 3-26-03, RB 3-27-03, RB 3-28-03, RB 3-31-03, and RB 4-01-03.
- Dissolved antimony was detected in RB-1 2-26-03 and RB-1 2-27-03.
- Dissolved barium was detected in RB-1 2-26-03 and RB-1 2-27-03.
- Dissolved calcium was detected in all of the rinse blanks.
- Dissolved copper was detected in RB-1 2-24-03 and RB-1 2-25-03.
- Dissolved iron was detected in RB 3-5-03, RB 3-6-03, and RB 3-7-03.
- Methylene chloride was detected in RB 3-5-03, RB 3-6-03, and RB 3-7-03.
- Dissolved selenium was detected in RB-1 2-25-03.
- Dissolved sodium was detected in RB 3-5-03, RB 3-6-03, RB 3-7-03, RB 3-10-03.
- Dissolved zinc was detected in RB-1 2-24-03 and RB 3-27-03.

POTESTA has concluded that the target analytes detected in the rinse blanks were due to laboratory error, laboratory contamination, or an anomaly. POTESTA has established that the insignificant concentrations detected in the rinse blanks do not identify a substantial QA/QC problem with the analytical data. A comparison of laboratory analytical results of the soil samples collected before and after collection of each of the rinse blanks is presented in **Table 11**.

5.4.4 Trip Blanks

No target analytes were detected in the trip blanks (**Appendix H**).

6.0 DISCUSSION OF SITE ASSESSMENT RESULTS

6.1 Soil Contaminants of Concern (COCs)

Those target analytes detected in the surface or subsurface soil at concentrations greater that their respective screening level or natural background were designated as COCs at the site (see **Section 5**). POTESTA reviewed the histories of products manufactured at the site in an attempt to establish whether the COCs could be correlated with a specific industrial operation.

Two of the COCs, tetrachloroethene and trichloroethene, were manufactured by the MACP. Daughter byproducts created by the degradation of these chemicals include vinyl chloride, which was designated as a COC in the groundwater.

In addition to the ethenes, several benzene compounds, PAHs, and metals were designated as COCs in the site soil. Barium and benzene compounds have been produced by PPG at their Natrium facility.

The PAHs and metal COCs could have been introduced at the site by MACP, PPG, or other party. Activities by MACP and PPG, discharges from a nearby coal burning power plant (American Electric Power's Moundsville facility), and impact from the railroad lines that cross the site, may have contributed to the PAH and metal COCs identified at the site.

6.2 Groundwater COCs

COCs in the groundwater included many of the same ethenes, benzenes, chlorides, and metals that were detected in the surface and subsurface soil can be traced to those industrial activities identified in **Section 6.1**.

6.2.1 Distribution of Groundwater COCs

COCs were identified in the samples from the six shallow and six deep monitoring wells. The distribution of the COCs is illustrated on **Figures 7** and **8**.

6.2.2 Groundwater Flow Direction

POTESTA measured groundwater elevations in the 12 monitoring wells installed during the ESA. A table listing these elevations is presented as **Table 3**. The groundwater elevations are illustrated on figures included with this report. **Figure 9** presents the groundwater elevations measured in the six shallow wells installed by POTESTA. **Figure 10** presents the groundwater elevations measured in the six deep wells.

The potentiometric surface drawn using shallow well data indicates the groundwater flow is from the east, northeast to the west, and southwest toward the Ohio River under the portion of the site evaluated by MWDEP-1A, MWDEP-2A, MWDEP-3A, and MWDEP-4A. However, the groundwater elevations measured in MWDEP-5A and MWDEP-6A are approximately 10 feet higher than their nearest offsets, MWDEP-3A and MWDEP-4A, respectively. Based on these data, POTESTA projects the groundwater under this portion of the site to flows from the west, southwest to the east, and northeast away from the Ohio River. The presumed direction of groundwater flow along the Ohio River (west to east) is 180 degrees opposite the apparent flow direction (east to west) as deduced from the data obtained from MWEDP-1A through MWDEP-3A.

The potentiometric surface drawn using deep well data indicated the groundwater flow at that lower horizon mirrors that described for the shallow water zone, but the difference in groundwater elevations near the Ohio River is not as severe. The measured groundwater elevations in MWDEP-1B through MWDEP-4B are nearly identical to those measured for their respective shallow well counterpart. The projected direction on groundwater flow under the eastern three-fourths of the site is from the east, northeast to the west, and southwest toward the Ohio River. The groundwater elevations measured in MWDEP-5B and MWDEP-6B are approximately one foot higher in elevation than their nearest offsets, MWDEP-3B and MWDEP-4B, respectively. As with the shallow water zone, POTESTA projects the groundwater under this portion of the site to flows from the west, southwest to the east, and northeast away from the Ohio River. The presumed direction of groundwater flow along the Ohio River is 180 degrees opposite the apparent flow direction as deduced from the data obtained from MWDEP-1B through MWDEP-2B.

POTESTA's calculations of groundwater elevations coincide with the groundwater elevations presented in a previous assessment of the site, specifically the groundwater elevations presented on *Plate: 4.2, Ground Water Contours with Well Locations*, prepared by TechLaw, Inc. (1996). A copy of a portion of that map is presented as **Figure 11**. Similar groundwater conditions were reported by IT Corporation in their *Verification Investigation Natrium Plant, New Martinsville, West Virginia* report, which sited groundwater elevation data obtained in 1989. ICF Kaiser Engineers, Inc. also reported similar groundwater conditions in their *Description of Current Conditions, RCRA Facilities Investigation for the PPG Industries, Inc. Natrium Plant, New Martinsville, West Virginia* October 1992 report. POTESTA concluded the groundwater elevation pattern identified at the site has existed for at least the past 14 years.

POTESTA's evaluation of groundwater flow direction indicates that the potential migration of groundwater off-site may be restricted by two factors: (1) PPG operates several water pumping wells which extract large volumes of process water; and, (2) the construction and operation of the Hannibal Dam, located downstream in New Martinsvillle, has acted to stabilize the elevation of the Ohio River. The approximate locations of the pumping wells are illustrated on **Figure 12**. The combination of influences from PPG drawing down the water table through extraction of large volumes of groundwater and the subsequent recharge of the aquifer from an unlimited source (the Ohio River) may have locally reversed groundwater flow to its current condition, east toward the PPG extraction wells. POTESTA observed that the average pool of the Ohio River is at a higher elevation (feet above mean sea level) than that measured in groundwater monitoring wells MWDEP-4A and MWDEP-3A (**Figure 9**). POTESTA field personnel observations during site assessment activities included "fish odor" descriptions of soil recovered from sample intervals below the water table during the installation of MWDEP-5A and MWDEP-5B. This may be evidence of Ohio River water, having a similar odor, being drawn into the aquifer as a result of PPG's draw-down of the water table at the site.

6.3 Assessment of Areas of Concern

POTESTA advanced soil borings and installed monitoring wells to assess the nine AOCs identified in previous environmental assessments of the site. These AOCs and the soil borings and/or monitoring wells installed to evaluate them are as follows:

Areas of Concern	Soil Boring/Monitoring Well
Former Sanitary Landfill	SB-22, SB-23, and SB-30
RCRA Hazardous Waste Drum Storage Area	SB-1 and SB-2
Storage Tanks	SB-9, MWDEP-1A, and MWDEP-1B
Former Process and Sewer Areas	SB-17 and SB-18
Used Oil Drum Storage Unit	SB-26
Used Drum Storage Area	SB-25, MWDEP-3A, and MWDEP-3B
Former 2,000-Gallon Used Oil Storage Tank (removed)	SB-26
Former Electrical Substation	SB-19
Dumpster Trash Compactor Unit	SB-28

6.3.1 Former Sanitary Landfill

The former Sanitary Landfill consisted of three cells, the last of which was closed in 1990. The landfill was used by PPG. POTESTA was unable to establish whether MACP used the sanitary landfill.

No target analytes were detected at concentrations greater than their Industrial RBCs in the soil samples analyzed from SB-22, SB-23, or SB-30.

6.3.2 Resource Conservation and Recovery Act (RCRA) Hazardous Waste Drum Storage Area

The RCRA Hazardous Waste Drum Storage area was used by PPG and issued a RCRA Part B Permit. Waste stored at this location included: distillation or fractionation column bottoms from the production of chlorobenzenes (waste code K085); spent halogenated degreasing solvents (F001), spent non-halogenated solvents (F003); and characteristically ignitable (D001), corrosive (D002), and mercury (D009) wastes.

No target analytes were detected at concentrations greater than their Industrial RBCs in the soil samples analyzed from SB-1 or SB-2.

6.3.3 Storage Tanks

No target analytes were detected at concentrations greater than their Industrial RBCs in the soil samples analyzed from SB-9, MWDEP-1A, or MWDEP-1B. Groundwater samples from MW-1A and MW-1B identified nine target analytes at concentrations greater than their Groundwater RBCs. A list of these target analytes is presented on **Table 7**.

6.3.4 Former Process and Sewer Areas

The sewer system was installed at the former MACP in the 1940s when the first plant was constructed and has been used by MACP and PPG.

No target analytes were detected at concentrations greater than their Industrial RBCs in the soil samples analyzed from SB-17 or SB-18.

6.3.5 Used Oil Drum Storage Unit

The Used Oil Drum Storage Unit included a curbed, concrete pad approximately 10 feet by 20 feet in size. This area was a storage area for used lubricating oil by PPG.

No target analytes were detected at concentrations greater than their Industrial RBCs in the soil samples analyzed from SB-26.

6.3.6 Used Drum Storage Area

PPG accumulated drums at the Used Drum Storage Area prior to transporting them for off-site disposal.

No target analytes were detected at concentrations greater than their Industrial RBCs in the soil samples analyzed from SB-25, MW-3A, or MW-3B. Groundwater samples from MW-3A and MW-3B identified 14 target analytes at concentrations greater than their Groundwater RBCs. A list of these target analytes is presented on **Table 7**.

6.3.7 Former 2,000-Gallon Used Oil Storage Tank (removed)

The 2,000-Gallon Used Oil Storage Tank used by PPG has been removed from the site.

No target analytes were detected at concentrations greater than their Industrial RBCs in the soil samples analyzed from SB-26.

6.3.8 Former Electrical Substation

The former Electrical Substation was constructed at the time MACP built their plant and was also used by PPG.

No target analytes were detected at concentrations greater than their Industrial RBCs in the soil samples analyzed from SB-19.

6.3.9 Dumpster Trash Compactor Unit

The Dumpster Trash Compactor processes solid waste generated throughout he PPG facility.

No target analytes were detected at concentrations greater than their Industrial RBCs in the soil samples analyzed from SB-28.

6.3.10 Former Waste Ponds/Sludge Basins

The former Waste Ponds/Sludge Basins were constructed by MACP. According to ICF Kaiser (1992) these units were intended for disposal of sub-tropical bleach wastes but MACP did not use these facilities. The Waste Ponds/Sludge Basins were used by PPG for the disposal of chloro-alkali plant, chlorinated benzene plant, and titanium tetrachloride plant wastes. The Waste Ponds/Sludge Basins were closed in 1979.

The soil borings nearest these units were SB-31, 32, 33, 36, 37, 38, and 39. The nearest monitoring wells were MWDEP-5A and 5B.

Arsenic was detected at concentrations greater than its Industrial RBC in the surface soil at SB-31, 33, and 36. Benzo(a)pyrene was detected at a concentration greater than its Industrial RBC in the surface soil at SB-36. Five VOCs, 1,1,2,2-tetrachloroethane, carbon tetrachloride, chloroform, tetrachloroethene, and trichloroethene, were detected at concentrations greater than their respective Industrial RBCs in the subsurface soil at SB-36. Eight VOCs, 1,4-dichlorobenzene, benzene, chlorobenzene, cis-1,2-dichloroethene, methylene chloride, tetrachloroethene, trichloroethene, and vinyl chloride, and two metals, arsenic and vanadium, were detected at concentrations greater than their respective Groundwater RBCs from the shallow water zone from MWDEP-5A. The pesticide beta-BHC was detected at a concentration greater than its Groundwater RBC from the deeper water zone from MWDEP-5B.

7.0 CONCEPTUAL SITE MODEL

The CSM was prepared based on historical data, previous studies, site assessment laboratory analytical results, and groundwater measurements. The CSM describes potential contaminant sources, release mechanisms, contaminant migration routes and exposure pathways for the site.

POTESTA prepared the CSM in general accordance with the guidance in Section 2.2.4 of the Guidance Manual. A copy of the "Checklist for Conceptual Site Model Development" is presented in **Appendix I**. A copy of the "Site Conceptual Exposure Model", created as part of the CSM, is presented in **Appendix J**.

7.1 Identification of Potential Sensitive Receptors and Migration Pathways

7.1.1 Primary Sources

The activities and materials that may have contributed to the contamination at the site include current industrial activities and those activities that have ceased to occur or have been removed. The primary source areas for COPCs are those areas where industrial activities are occurring, the subsurface and fill areas, and surface and subsurface soil and groundwater that have been impacted by the COPCs.

7.1.2 Release Mechanism

The primary release mechanism for potential new sources of contamination would be from industrial equipment used or stored at the site. The primary release mechanism for residual contamination is through leaching to subsurface soil or groundwater. Several COPCs may potentially volatilize to air.

The majority of the site is covered with structures, pavement, gravel, and vegetation. The covered areas reduce the exposure of surface soils to wind erosion. POTESTA concluded that wind distribution of contaminated soil particles to off-site locations is an insignificant release mechanism for contaminant distribution.

7.1.3 Potential Contaminant Migration

POTESTA evaluated the potential contaminant migration pathways at the site. The potential primary migration pathway that exists at the facility is migration of analytes through the surface and subsurface soil to groundwater. As previously discussed, the off-site migration of contamination to the Ohio River may be restricted by the extraction of large volumes of groundwater by PPG wells.

7.2 Potential Human Receptors

The potential pathways of transport and release, as well as the human activity patterns, were used to evaluate potential human exposures at the site. The human exposure pathway consists of:

- source of contaminant,
- mechanism of contaminant release to the environment,
- transport or exposure medium containing the contaminant,

- exposure point where receptors can contact the exposure medium,
- exposure route (i.e., inhalation, absorption, or ingestion), and
- a receptor.

Exposure can only occur if these six elements are present.

COPCs from the primary sources may be released to the surrounding environment primarily through infiltration of precipitation and the migration of groundwater. The following groups are considered to be potential human receptors for exposure from the site:

- on-site construction workers,
- on-site workers, and
- visitors.

Potential routes of exposure to human receptors at the site include:

- ingestion of soil and/or dust;
- dermal contact with soil and/or dust;
- dermal contact with groundwater; and
- inhalation of vapors and/or particulate-bound chemicals.

Although POTESTA has concluded that wind distribution of contaminated soil particles to off-site locations is an insignificant release mechanism for contaminant distribution, site workers and construction workers may be exposed to localized vapors/particles during earth moving activities and that exposure pathway is evaluated in this assessment.

8.0 CONCLUSIONS AND RECOMMENDATIONS

As a result of this ESA, POTESTA has identified the VOC 1,4-dichlorobenzene, the SVOCs hexachlorobenzene and hexachlorobutadiene, the PAH benzo(a)pyrene, and the metal arsenic at concentrations in the surface soil, which exceeded their respective Industrial RBCs. The VOCs 1,1,2,2-tetrachloroethane, 1,4-dichlorobenzene, carbon tetrachloride, chloroform, tetrachloroethene, and trichloroethene, and the PAHs benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were detected at concentrations in the subsurface soil, which exceeded their respective Industrial RBCs.

POTESTA has identified VOCs 1,1,2,2-tetrachloroethane, 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, benzene, carbon tetrachloride, chlorobenzene, chloroform, cis-1,2-dichloroethene, methylene chloride, tetrachloroethene, trichloroethene, and vinyl chloride, SVOCs bis(2-ethylhexyl)phthalate and hexachloroethane, pesticides beta-BHC and dieldrin, and metals arsenic, mercury, thallium, and vanadium at concentrations which exceeded their respective Groundwater RBCs.

POTESTA did not identify COCs in the soil samples associated with AOCs. Surface and subsurface soil may have been impacted by releases from the Waste Ponds/Sludge Basins. Groundwater contamination seems pervasive.

POTESTA measured groundwater elevations in the 12 monitoring wells installed during the ESA. A potentiometric surface map drawn using shallow well data indicates the groundwater flow is from the east, northeast to the west, and southwest toward the Ohio River under the eastern portion of the site. The groundwater elevations measured in wells adjacent to the Ohio River are approximately 10 feet higher than the nearest offsets. Based on these data, POTESTA projects the groundwater under the western portion of the site to flows from the west, southwest to the east, and northeast away from the Ohio River. POTESTA's calculations of groundwater elevations coincide with the groundwater elevations presented in a previous assessment of the site.

To adequately characterize the site, POTESTA recommends the following:

- Reviewing available sediment and surface water data that may exist from the Ohio River adjacent to the site;
- If necessary, collecting and analyzing sediment and surface water samples along riverbanks of the Ohio River adjacent to the site;
- Evaluating the perimeter monitoring system as recommended by International Technology Corporation;
- Evaluation of groundwater extraction rates and volumes through PPGs pumping wells, and
- Evaluation of historical groundwater analytical data and comparison to current/recent data. An effort should be made to evaluate the progress of remediation of the aquifer resulting from PPGs pumping wells.

If requested, POTESTA will prepare a supplemental work plan for the WVDEP that will describe the additional assessment services to be performed in response to the listed recommendations.

9.0 CLOSING

This report was prepared to assist the WVDEP-OER in evaluating and planning with respect to the subject site. The scope of this study was mutually devised by POTESTA and the WVDEP-OER and is limited to the specific project, location and time period described herein. The scope of services and report represent POTESTA's understanding of site conditions as discernible from information provided by others and obtained by POTESTA using the methods specified. POTESTA assumes no responsibility for information provided or developed by others, or for documenting conditions detectable with methods or techniques not specified in the scope of services. In addition, no activity, including sampling, assessment or evaluation of material or substances, may be assumed to be included in this study unless specifically considered in the scope of service and this report. Sketches and maps in this report are included only to aid the reader and should not be considered surveys or engineering studies. If additional data concerning this site becomes available, POTESTA should be informed so that we may examine the information and, if necessary, modify this report accordingly.

Respectfully Submitted,

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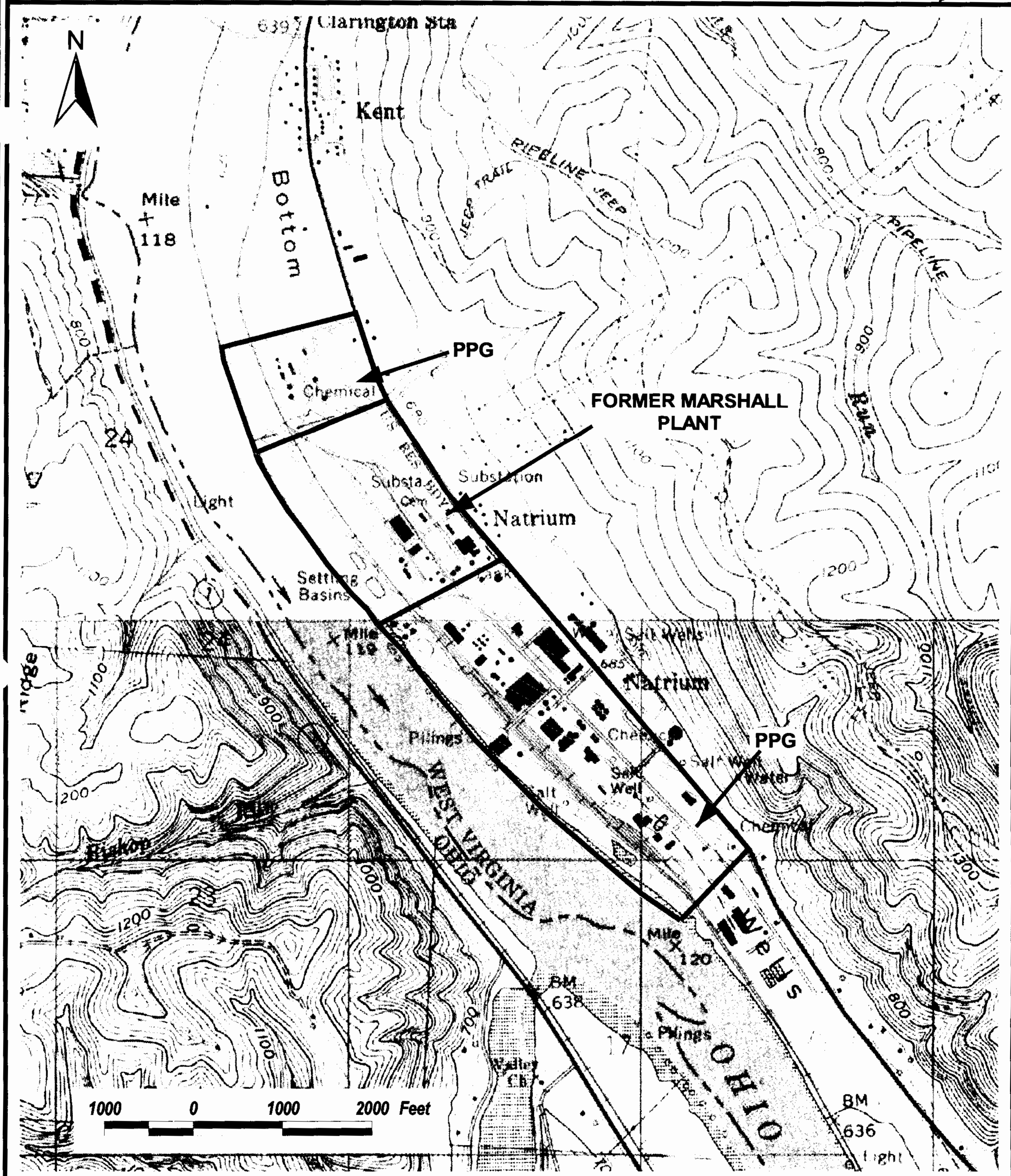

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FIGURE 1

SITE LOCATION MAP
FORMER MARSHALL ARMY CHEMICAL PLANT
NATRIUM, MARSHALL COUNTY WEST VIRGINIA
POTESTA PROJECT: 02-0119
WVDEP PROJECT: No. 04877